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ON REACTION-TIMES WHEN THE STIMULUS IS APPLIED TO THE REACTING HAND.¹

In his classical study of reaction-times Exner was led to the opinion that the reaction-time for electrical stimulation is longer by about 10σ when the stimulus is received in the reacting hand than when it is received in the other hand.² This result, as Exner himself remarks, is just the opposite of what might be expected, and, as his conclusion rests upon relatively few trials, invites a repetition of the experiment. The purpose of this short paper is to give the results of a careful repetition.

Apparatus and Methods. The reaction-times were measured with the Hipp chronoscope, set up to start at the closing of the electrical circuit and to stop at the breaking. The regularity of the chronoscope was tested with the Cattell fall-apparatus, adjusted to give an interval of not far from 130σ , but as the question to be answered was one of relative and not absolute times, it seemed unnecessary to seek an absolute correction of the chronoscope. The conditions were the same in all cases for the experiments to be compared, and the constant error remaining cannot amount to more than 10σ . The stimulus was an induction shock of moderate intensity, applied by small platinum electrodes let into the surface of the knob of the reacting key, and of a similar key upon which the finger of the passive hand rested. The stimulus was applied alternately to the end of the finger in the reacting and in the passive hand, the alternation being used to equalize practice, fatigue, strength of shock and all other conditions as exactly as possible. A Pohl commutator in the secondary circuit made it easy to shift the stimulus from one hand to the other without disarrangement of the other parts of the apparatus. Tests were made upon three subjects, S., B. and R.

¹The essential experiments shown in Table I. were made by Mr. J. F. Reigart. The statement of the results, however, has been left to me.

E. C. S.

²Exner: Experimentelle Untersuchung der einfachsten psychischen Prozesse, Pflüger's Archiv, VII., 1873, pp. 622-623, and 655-656; also Hermann's Handbuch der Physiol.

All had worked before at reaction-time experiments, and none was ignorant of the object of the tests, but it is believed that this had little or no effect upon the result. In all cases the stimulus was preceded by a ready-signal, and the subject responded as quickly as he could. In taking the tests, Exner's own method of excluding irregular reactions was rigorously applied. The subjects, after each reaction, passed judgment upon it, calling it "good," "too late," or "too early," as the case might be. All the reactions accepted as good by the subject, and those only, were used in computing the averages.

Results. The results of the tests are given in the following tables:

TABLE I.

Stimulus alternately in the right and left hands. Subject selected the satisfactory reactions.

REACTION WITH RIGHT HAND.

SUBJECT.	STIMULUS IN RIGHT HAND.				STIMULUS IN LEFT HAND.			
	Total No. of Reactions	No. of re-actions Selected.	Average.	Av. v.	Total No. of Reactions	No. of re-actions Selected.	Average.	Av. v.
S.	30	10	128.4	8.	25	10	142.7	9.
B.	27	22	145.8	10.1	25	21	143.4	6.8
R.	14	11	153.3	6.6	14	13	150.0	6.1

REMARK: Subject S. seemed more critical in selecting when the stimulus was in the reacting hand. The shock seemed to him stronger in the left hand.

REACTION WITH LEFT HAND.

Subject.	STIMULUS IN RIGHT HAND.				STIMULUS IN LEFT HAND.			
	Total No. of Reactions	No. of re-actions Selected.	Average.	Av. v.	Total No. of Reactions	No. of re-actions Selected.	Average.	Av. v.
S.	15	10	141.9	10.9	26	10	140.2	5.8
B.	24	22	148.2	10.9	24	24	131.3	8.1
R. ¹	15	11	166.7	13.9	15	15	163.0	29.3
R. ²	25	19	138.1	10.9	26	23	136.6	8.6

REMARK: Same remark as above for subject S. R.'s first and second series were taken a little more than a month apart.

It will be observed that the results of this table are opposed to those of Exner, except in the cases of B. and R. when reacting with the right hand, and even in those cases the excess when the stimulus was in the reacting hand is too small to be regarded.¹ In the case of S. when reacting with the right hand, and of B. when reacting with the left, the differences are larger than those found by Exner and in the contrary direction. The remark on the reactions of S., especially with reference to his greater strictness of selection when the stimulus was in the reacting hand, would at first sight seem to weaken the force of his figures. This strictness was, however, certainly not due to conscious prejudice, and may very well point to a keener sense of the difference between prompt and delayed reactions when the stimulus and reaction are on the same side. If this is the case, the point would tend to support rather than oppose the statement which the rest of the table justifies, namely, that it makes very little difference which hand receives the stimulus. The variation of the experiment giving the second half of Table I. (not tried by Exner) excludes the possibility that previous practice in reacting with the right hand should have given that hand an advantage in quickness.

The same practical equality of the reaction-times when the stimulus is given alternately right and left was shown, though by somewhat uneven figures, in an experiment made upon

¹In order to facilitate comparison, Exner's results have been put in the form of Table I.; the full figures will be found in the place cited above, pp. 655-656.

REACTION WITH RIGHT HAND.

Subject.	STIMULUS IN RIGHT HAND.				STIMULUS IN LEFT HAND.			
	Total No. of Reactions	No. of re- actions Selected.	Average.	Av. v.	Total No. of Reactions	No. of re- actions Selected.	Average.	Av. v.
E.	8	6	139.0	4.1	17	11	128.3	5.4
v. B.	12	4	146.9	3.7	12	3	138.1	4.3

The subject E. was Exner himself; the subject v. B. had never engaged in such experiments before. In the case of v. B. some of the reactions were called *ziemlich gut* or *nahezu gut*; these Exner excluded from the averages, as also two reactions that were called good by the subject, but were considerably larger than the rest.

another subject and at an earlier time by Dr. Sanford.¹ In this experiment a genuine touch with a hard rubber point was used as the stimulus instead of an electric shock. The result is given in Table II.

¹The experiment here referred to was made with a number of others soon after the opening of the University, and before the full equipment of the laboratory. The times were measured with the Hipp, but the battery used was not of the most constant kind and the regulating apparatus was the antiquated Hipp ball-dropper. The results given in Table II., however, are regarded as valid for purposes of comparison between right and left, for the stimuli were alternately applied and both quantities may be assumed to have been equally affected by what changes occurred. At the same period experiments were tried with electrical stimulation of the finger on each side, but it was difficult to secure uniform intensity of shock and for that reason less confidence is felt in them. They were made upon three subjects, with some variety of conditions. With two of these the differences were small and now in one direction, now in the other. With the third—the least experienced and probably, also, the least informed as to the purpose of the experiment—part of the figures agree in direction with those of Exner, as appears in the following little table. The figures given are those for averages, corrected as in Table II., but in no case does the correction alter the direction of the difference.

In the first, third and fifth series the results for this subject agree in nature with those of Exner.

	STIMULUS RIGHT.		STIMULUS LEFT.	
	Average.	Av. v.	Average.	Av. v.
Reaction with right hand, pressing key,	155.3 147.9 144.7	11.7 12.3 20.1	146.6 147.0 130.0	9.9 10.5 10.8
Reaction with left hand, pressing key,	173.1	13.5	166.0	17.3
Reaction with right hand, withdrawing finger from key,	183.4	15.1	178.8	11.4

TABLE II.

Stimulation by contact, alternately right and left. Stimulus applied in the first set to the back of the hand; in the second set to the second joint of the thumb. Reaction in the first set by pressing a key with finger of right hand; in the second set by removing finger from the key. Subject A.

Subject.	STIMULUS IN RIGHT HAND.			STIMULUS IN LEFT HAND.		
	No. of Tests.	Average.	Av. v.	No. of Tests.	Average.	Av. v.
A¹	25	118.4	21.7	25	132.4	19.0
	22	113.9	13.8	22	127.7	13.7
A²	24	141.9	19.4	24	139.7	19.9
	21	135.7	13.7	21	136.4	16.0

The corrected results in this table, indicated by heavy faced type, were reached by rejecting from the corrected averages the three reaction-times most variant from the original uncorrected average.

Of the same tenor is the result of an experiment upon R., when no selection by the subject was attempted. The stimulus was applied alternately right and left; the reaction was with the right hand. When the stimulus was in the reacting hand, 22 tests gave a mean of 124.4σ with an average variation of 8σ ; when in the other hand, a mean of 140σ with an average variation of 7σ . Casting out from each 22 the three reactions most variant from the mean, the remaining 19 average respectively 124σ and 140σ , and the average variations are 6σ and 5σ .

With this agree also some measurements made by Dumreicher,¹ though his point was the discovery of the conditions giving the greatest uniformity of results rather than the greatest quickness. He found for reaction by withdrawing the finger from the key (the stimulus was given through electrodes in the knob of the key) 126σ when the stimulus was in the reacting hand and 158σ when in the other hand; and for reaction by pressing the key, 173σ and 187σ respectively. His measurements were made with Ewald's chronoscope.

¹ Zur Messung der Reactionszeit, Inaug. Dis., Strasbourg; pp. 43, 44.